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ABSTRACT

A study investigated how two text-based factors, word relationships and surface syntactic structure, interact with readers' ability to analyze the semantic relationships and make inferences based on those analyses. In each passage, the influence of word relationships was assessed by manipulating the degree of semantic entailment between two words in a passage; the syntactic structure's influence was determined by manipulating the syntactic class in which the entailing word appeared. Subjects, 20 skilled and 20 less skilled high school readers, rated the degree to which a verb involved an associated case. Results demonstrated that the presence of entailing words significantly improved the ability of all readers to infer action-case relationships. However, reader skill interacted with entailment to produce significant differences in passage comprehension. Skilled readers were (1) more efficient at analyzing the semantic relationships present in text, (2) better able to use other semantic information to make inferences when entailing words were absent, and (3) less dependent on explicit text-based factors for semantic analysis than were less skilled readers. (Tables of data and an eight-page reference list are included.) (JD)

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Semantic and Syntactic Bases of Text Comprehension

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In order to comprehend, readers must be able to analyze, integrate and make inferences about the information present in text. Recent research suggests that the success of these processes is determined by the interaction of two sources of information: (1) factors in the text that affect its readability and (2) the skill with which the reader performs the various processes that comprise "reading". The purpose of this research was to investigate the way in which two text-based factors, word relationships and surface syntactic structure, interact with reader skill to affect readers' ability to analyze the semantic relationships present in text and to make inferences based on those semantic analyses. The influence of word relationships was assessed by manipulating the degree of semantic entailment between two words in a passage. Entailing words are those that are thought to semantically obligate the presence of an associated case word (e.g., the action "murdered" obligates the presence of an agent case word "the killer" and a

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patient case word "the victim"; the action "died" does not obligate these case words). The influence of syntactic structure was assessed by manipulating the syntactic class (verb/adjective) in which an entailing word appeared in a passage.

The results demonstrate that the ability of all readers to infer action-case relationships was significantly improved by the presence of entailing words. However, reader skill interacted with entailment to produce significant differences in passage comprehension. First, skilled readers were more efficient at analyzing the semantic relationships present in text than were less skilled readers. Second, skilled readers were better able than less skilled readers to use other semantic information to enable inferences when entailing words were absent. Finally, less skilled readers appeared to depend more on explicit text-based factors like entailing/verb structures to enable semantic analysis than less skilled readers. Theoretical implications of the findings are discussed, focusing in particular on the interactions that occur between word relationships and reader skill during text comprehension. Implications for instruction in vocabulary and comprehension are discussed.

Abstract

In order to comprehend, readers must be able to analyze, integrate and make inferences about the information present in text. Recent research suggests that the success of these processes is determined by the interaction of two sources of information: (1) factors in the text that affect its readability and (2) the skill with which the reader performs the various processes that comprise "reading". The purpose of this research was to investigate the way in which two text-based factors, word relationships and surface syntactic structure, interact with reader skill to affect readers' ability to analyze the semantic relationships present in text and to make inferences based on those semantic analyses. The influence of word relationships was assessed by manipulating the degree of semantic entailment between two words in a passage. Entailing words are those that are thought to semantically obligate the presence of an associated case word (e.g., the action "murdered" obligates the presence of an agent case word "the killer" and a patient case word "the victim"; the action "died" does not obligate these case words). The influence of syntactic structure was assessed by manipulating the syntactic class (verb/adjective) in which an entailing word appeared in a passage.

The results demonstrate that the ability of all readers to infer action-case relationships was significantly improved by the presence of entailing words. However, reader skill interacted with entailment to produce significant differences in passage comprehension. First, skilled readers were more efficient at analyzing the semantic relationships present in text than were less skilled readers. Second, skilled readers were better able than less skilled readers to use other semantic information to enable inferences when entailing words were absent. Finally, less skilled readers appeared to depend more on explicit text-based factors like entailing/verb structures to enable semantic analysis than skilled readers. Theoretical implications of the findings are

discussed, focusing in particular on the interactions that occur between word relationships and reader skill during text comprehension. Implications for instruction in vocabulary and comprehension are discussed.

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1. LITERATURE REVIEW

1.1 Introduction

In order to comprehend, a reader must be able to analyze and identify the various semantic relationships that exist among the propositions in a text. Current theories of text processing suggest that two different sources contribute to the difficulty of text comprehension: (1) the readability of a text itself and (2) the skill with which a reader performs the component processes that comprise "reading". Text readability refers to those characteristics of text that affect its comprehensibility. Factors like word frequency and sentence complexity have long been regarded as indices of text difficulty (Chall, 1958b; Klare, 1974–1975). More recently, the contributions that particular text elements (e.g., argument repetition, topicalization, semantic relatedness) make to text difficulty have also been the focus of research (Kintsch & Vipond, 1976; Lesgold, Roth, & Curtis, 1978; Rosebery, 1982).

Reader skill refers to the expertise with which a reader processes the information present in text; like readability, reader skill also affects comprehension. For instance, inefficiency in the operation of any one of a number of critical component skills (e.g. word analysis, lexical access, referent identification) can lead to comprehension difficulty (West & Stanovich, 1978; Perfetti & Roth, 1981; Frederiksen, 1978, 1981b). Although the individual contributions that both of these sources of information make to comprehension are recognized, the effect that they produce in interaction with one another has been investigated only recently (Kintsch & Vipond, 1976; Frederiksen & Warren, 1985). This shift in focus represents an attempt to conceptualize comprehension as a dynamic process in which the reader constructs a meaningful representation from the information contained in a text.

To illustrate this perspective, two examples will be considered in which reader skill and text characteristics interact to influence comprehension. Toward this end, the following passage has been taken from Mark Twain's The Adventures of Tom Sawyer (1946). The passage comes from Chapter 9, entitled "Tragedy in the Graveyard" in which Tom and Huckleberry Finn witness the murder of young Doctor Robinson by Injun Joe.

> "Yes, and you done more than that," said Injun Joe, approaching the doctor, who was now standing. "Five years ago you drove me away from your father's kitchen one night, when I come to ask for something to eat, and you said I warn't there for any good; and when I swore I'd get even with you if it took a hundred years, your father had me jailed for a vagrant. Did you think I'd forget? The Injun blood ain't in me for nothing. And now I've got you, and you got to settle, you know!"
>
> He was threatening the doctor, with his fist in his face, by this time. The doctor struck out suddenly and stretched the ruffian on the ground. Potter dropped his knife, and exclaimed: "Here, now, don't you hit my pard!" and the next moment he had grappled with the doctor and the two were struggling with might and main, trampling the grass and tearing the ground with their heels. Injun Joe sprang to his feet, his eyes flaming with passion, snatched up Potter's knife, and went creeping, catlike and stooping, round and round the combatants, seeking an opportunity. All at once the doctor flung himself free, seized the heavy headboard of Williams's grave and felled Potter to the earth with it--and in the same instant the half-breed saw his chance and drove the knife to the hilt in the young man's breast. He reeled and fell partly upon Potter, flooding him with his blood, and in the same moment the clouds blotted out the dreadful spectacle and the two frightened boys went speeding away in the dark. (pp.94-95)

Let us examine first an instance in which reader skill and text characteristics interact to facilitate passage comprehension. Consider the repetition of the phrase "the doctor" from the first sentence in the second paragraph to the second sentence ("He was threatening the doctor, with his fist in his face, by this time. The doctor struck out suddenly and stretched the ruffian on the ground.") Repetition of "doctor" in the second sentence is purposeful: it identifies the doctor as the assailant and Injun Joe as the victim; no room is left for misinterpretation. The reader's task is made easier because these role assignments can be made directly. If however, Twain had chosen to

substitute the repeated noun phrase "doctor" with the pronoun "he", comprehension of the passage would be much more difficult (e.g. "He was threatening the doctor, with his fist in his face, by this time. He struck out suddenly and stretched the ruffian on the ground."). Use of a pronoun in this instance makes the identity of the assailant ambiguous, especially since Injun Joe is the aggressor in the previous sentence. This ambiguity increases comprehension difficulty for all readers. However, the task facing the less skilled reader is made especially difficult. These readers frequently experience difficulty in tracing semantic relationships and constructing inferences. Thus, they are especially likely to experience confusion about the identify of the referent for "he". For these readers then repetition of the noun phrase "the doctor" may in fact enable comprehension of passage information. This example illustrates one way that readers in general, and the less skilled reader in particular, benefits from an increase in text readability (see also Chall, 1958b, 1983; Gates & Russell, 1938).

Let us examine now an instance in which reader skill interacts with text characteristics to disrupt comprehension. Consider the phrase "--and in the same instant the half-breed saw his chance" in the third paragraph. Comprehension of this phrase depends, to a great extent, on the reader's ability (a) to analyze the semantic relationships that exist between newly encountered information (e.g. the half-breed) and previously understood information current in the reader's text model (other information about Injun Joe) and (b) to make an inference based on semantic connections. The expert reader, who has a repertoire of skills to evoke in the service of semantic analysis, is more likely to comprehend this paragraph than is the less skilled reader. Let us examine this difference by focusing on the first problem that the reader must solve: identification of a referent for "the half-breed". From an information processing perspective, this identification involves a complex series of processes. Referent identification is thought to include processes such as searching

memory for related, previously understood information ("The Injun blood ain't in me for nothing."), changing the memory status of this information so it is available for ongoing processing, locating a semantic base to which "half-breed" can be related, and finally, constructing an inference to connect "half-breed" to "Injun Joe". The reader who experiences difficulty in any one of these component processes, or in any one of the number of processes that support semantic analysis (e.g. word analysis, semantic priming, lexical retrieval, etc.) may have trouble identifying Injun Joe as "the half-breed" and, as a result, as the killer. This difficulty can, in turn, have serious consequences for passage comprehension. In the case of the less skilled reader, a lack of expertise in any one of these critical components can lead to comprehension difficulty. This example illustrates one way that reader skill can interact with text characteristics in a way that may disrupt comprehension.

Examination of the Twain passage illustrated some of the ways that reader skill and text characteristics can interact to influence comprehension. To date, cognitive research has focused principally on the effect that one or the other of these factors has on comprehension. Although cognitive research has demonstrated the impact that text characteristics and reader skill can have on comprehension individually, it has not often focused on the influence that they have on one another; nor has it often focused on how the resulting interactions affect comprehension. My research seeks to address these issues by conceptualizing comprehension as the product of an interaction between reader skill and text characteristics. Of primary interest in my research is the influence that two text characteristics, (1) the semantic relationships among words and (2) the surface syntactic category of a word, have on the ability of skilled and less skilled readers to analyze semantic relationships in text. A related interest is the implication that these interactions have for comprehension instruction.

The influence of word relationships on comprehension in skilled and less skilled readers was investigated by manipulating the degree of semantic entailment between two words in a passage. Entailing words are those that are thought to semantically obligate the presence of an associated case word (e.g. agent, patient, object, etc.). For example, an important distinction between the word "died" and the phrase "was murdered" is the obligatory presence of an agent (i.e., the "killer") that is semantically associated with the latter phrase. Manipulation of the strength of semantic ties between words in a passage allows examination of the influence that semantic relationships have on text comprehension.

The influence of surface syntactic category was assessed by manipulating the syntactic class in which a word appeared in a passage. For example, a concept such as "being murdered" can be encoded as a verb, as in "the actress was murdered", or as an adjective, as in "the murdered actress". A comparison between verb-based information and adjective-based information allows an assessment of the influence that surface syntactic structure has on text comprehension.

Finally, an examination of the performance of skilled and less skilled readers in these textual situations allows an investigation of some reader-based sources of comprehension difficulty. It is hoped that an identification of performance differences between skilled and less skilled readers will have implications for the development of skill in semantic analysis in particular and for comprehension instruction in general.

In the remainder of this chapter, the nature and some of the sources of comprehension difficulty are examined within this interactive framework. First, current understanding of the effects that the text characteristics of word relationships and verb structures have on readability and language comprehension are reviewed. This is followed by an examination of the effect that reader skill has on text comprehension.

1.2 Influence of Word Relationships on Text Comprehension

The semantic relationships that hold among words are known to influence the performance of processes such as word recognition and word naming. Research has demonstrated that such relationships can facilitate and, in some cases, inhibit word recognition, depending upon the efficiency of a reader's decoding processes (Meyer, Schvaneveldt & Ruddy, 1973; West & Stanovich, 1978; Perfetti & Roth, 1981; Frederiksen, 1981a). Similar to the interactions described above, facilitated word recognition is also thought to be the result of an interaction between text characteristics (i.e. the featural and orthographic information present in a text) and reader skill (i.e. semantic information made available by processes operating in semantic memory). This section will examine the effect that semantic relationships among words, in contexts ranging from single words and single sentences to short passages, exercise on ongoing processing in reading.

Research investigating single word and single sentence contexts has demonstrated that when a context is semantically related to a target word, processes of word recognition and word naming are facilitated (Meyer et al., 1973; West & Stanovich, 1978; Fischler & Bloom, 1978). For example, the word "doctor" is recognized faster when it is preceded by the word "nurse" than when it is preceded by the word "butter" (Meyer, et al., 1973). Theories of semantic activation propose that this effect is due to reader-based processes that operate in semantic memory. In particular, recognition of a concept such as "nurse" is thought to activate, or "prime", other concepts in memory in proportion to the strength of association among them (i.e., "hospital", "medicine", "doctor", etc.; cf. Collins & Loftus, 1975; Anderson, 1975). This state of heightened activation, in combination with text-based information about letter identity, speeds recognition of the printed form of a target word such as

"doctor". Thus, facilitated word recognition is thought to result from an interaction between memory-based processes of spreading activation and text-based information about letter and multi-letter unit identity (West & Stanovich, 1978; Fischler & Bloom, 1978; for a review of this literature, see Warren, 1982).

Although current theories of semantic activation can account for instances of single word and single sentence priming, they are hard pressed to explain facilitation that occurs during the comprehension of extended text. Semantic activation is typically short-lived, with decay usually occurring during the time it takes to display a single, unrelated word between two related words (Meyer, et al., 1973; Gough, Alford & Holley-Wilcox, 1981). Given this rapid decay rate and the observation that semantically related words are interspersed throughout a text, it is unlikely that heightened activation alone can account for facilitation that occurs during text comprehension. Instead, research investigating the effect that words related to the central theme of a text have on comprehension has suggested another process by which such facilitation may be produced. This research suggests that information that is perceived as important to ongoing integration may be given special status in memory over other information perceived as less important to integration. For example, the evidence suggests that information that is related to the central theme of a text and information that has been processed most recently may be kept active in memory. It is this active status that is thought to make certain information available to aid the integration of incoming information (Kintsch & van Dijk, 1978; Lesgold, Roth & Curtis, 1978; Foss, 1982; Rosebery, 1983)

The differential memory status of information perceived as important to integration is thought to be the result of a capacity limitation that is present in human memory. Recent research has demonstrated that the amount of information that

is available for processing at any one time is limited (Kintsch & van Dijk, 1978; Lesgold, Roth & Curtis, 1978). A limitation on the quantity of information that can be processed at any one time has implications for the manner in which text is processed. One important implication is that information is kept actively in mind (or in working memory) in systematic ways. For example, research indicates that information that is perceived as important to ongoing processing is kept active. Other information, current in the reader's text model but not needed immediately for integration, is thought to be stored in long term memory (Kintsch & van Dijk, 1978; Lesgold, Roth & Curtis, 1978; Foss, 1981; Rosebery, 1982).

In exploring the hypothesis that working memory is limited, research has sought to identify the kinds of information that are perceived as important to comprehension and are, in turn, favored for active status. Several kinds of semantic relationships that appear to influence the ease with which text is processed have been identified. For example, using cognitive research and computer simulation, Kintsch & van Dijk (1976) investigated the effect that the relationship of simple repetition has on text comprehensibility. They found that texts that contained arguments that were repeated from one proposition to another were processed faster than texts that did not contain argument repetitions. Kintsch & Van Dijk hypothesize that processing is facilitated because the repeated argument can be mapped directly onto the original argument that is currently active in memory. Because integration can proceed in a straightforward manner, there is no need for further semantic analysis (i.e. search of long term memory for related information, identification of an appropriate referent, inference).

Taking a different approach, Foss (1982) investigated the differential effect that word relationships have on listeners' ability to process word lists and discourse. He

found that when the words in a text were scrambled and presented in list form, facilitation was present only when semantically related word pairs occurred adjacent to one another. When those same words were presented as connected discourse, however, facilitation was present regardless of whether the related words were separated by as few as 1.5 words or as many as 12 words.

In a study related to Foss's, Rosebery (1983) investigated the influence that semantic relationships have on the ease with which individual words in a passage are read. By varying the strength of semantic association between words in a passage, she found that a word having a strong semantic association with a word occurring early in a passage was processed more quickly than was that same word when it was preceded by a less strongly associated word. For example, when a word like "arsonist" occurred in the first sentence of a three-sentence passage, facilitation was evident on the reading time of the related word, "ignite", when it occurred in the third sentence. This facilatory effect persisted when as many as 41 words intervened between the related words.

Together, these studies suggest that semantic relationships among the words in text can influence the ease with which it is comprehended. This facilitation is thought to be the result of processes which keep the representation of certain information active in memory. An activation-based model proposes that it is the activation level of a representation that determines its status in memory. If that level is above threshold, the representation is kept active in working memory; if the activation level falls below threshold, the representation is transferred to long term memory. A representation is thought to receive activation when it is involved in a processing cycle. Thus, the activation level of those representations that are used in ongoing cycles of integration (e.g. those related to the central theme of a text) remains high.

On this basis it is hypothesized that information that is likely to facilitate integration is favored for retention in working memory.

Other research has focused on the effect that a particular kind of word relationship, that holding between an action and an associated case (e.g. action–instrument relation: pitch–baseball; action–agent relation: murder–killer), has on text comprehension. This research is beginning to specify the influence that action–instrument relationships in particular have on readers' ability to make inferences (Singer, 1979, 1980; McKoon & Ratcliff, 1982).

For example, Singer (1980) found that knowledge of action–instrument relationships enabled readers to understand a relationship that was implied in a text as easily as when that same relationship was explicitly stated in a passage. Readers were given passages like the following one in which an action–instrument relationship was either explicit or implicit, as illustrated in the following sample passages. Their task was to judge the sensibility of a final target sentence.

Passage 1, Explicit Condition

a. The pitcher threw the ball to first base.
b. The runner was halfway to second.

Target: The pitcher threw the ball to first base.

Passage 2, Implicit Condition

a. The pitcher threw to first base.
b. The ball sailed into the field.

Target: The pitcher threw the ball to first base.

Singer (1980) found that readers were as accurate and efficient in the implicit condition (Passage 2) as they were in the explicit condition (Passage 1). He hypothesized that readers' pre–existing knowledge of the action–instrument relationship (e.g. "threw"–– "ball") facilitated comprehension of the inference in the implied condition.

While Singer looked at the facilitory effect that an action has on recognition of its related instrument, McKoon & Ratcliff (1982) investigated the facilitory effect that an instrument has on recognition of its related action. Interestingly, they found that the facilitory effect can be influenced by word frequency. For instance, when a high frequency instrument like "hammer" occurred in a passage, recognition of its related action "pound" was facilitated when "pound" was presented directly after the passage. However, when a low frequency synonym like "mallet" was substituted for "hammer", no facilitation was present. This suggests that the strength of the semantic relationship that exists between an action and an instrument, and thus its facilatory effect on text comprehension, may be determined to some degree by word frequency. This is consistent with the findings of Chall (1958b) and others (Gates and Russell, 1938; Dale and Chall, 1948; Dolch, 1948) that demonstrates the strong influence that word frequency can have on text comprehension and readability.

Finally, a study by Just & Carpenter (1978) allows a more detailed examination of the influence that action–case relationships have on comprehension. In this study, readers were given passages in which the strength of association between a target case word and a related action word was varied (e.g. killer–was murdered and killer–died). Readers spent less time reading a target sentence that contained an associated case (e.g. killer) when the preceding text contained a strongly related verb (e.g. was murdered) than when it contained a less strongly associated verb (e.g. died). This suggests that, in the absence of strong semantic ties, additional processing may be needed to integrate the new information contained in words like "killer" with previously understood information. Examination of time spent reading individual words revealed that more time was spent reading the actual target word (e.g., killer) when the text contained a less associated verb (e.g., died) than when the text contained a highly associated verb (e.g., was murdered). This suggests that the target word itself might have been a locus for additional processing.

Although the research reviewed here demonstrates that word relationships are capable of affecting high level comprehension processes, the nature and the sources of this influence have not been specified fully. For example, theories of semantic activation, used to explain single word and single sentence priming phenomena, cannot by themselves account for the facilitation that occurs during processing of connected text. However, other evidence suggests that processes in semantic memory facilitate ongoing integration. Furthermore, it appears that the influence that semantic relationships have on text comprehension may not be straightforward. In some cases, evidence of facilitation is strong; in other cases, the facilitory effect has been shown to be negated by word frequency. The present study investigates more fully the interaction that occurs between word relationships in text and individual reading skill and the effect this interaction has on comprehension.

1.3 The Influence of Verbs on Text Comprehension

Like semantics, syntactic structure is also known to affect language and reading comprehension. For example, theories of grammar and systems of natural language understanding propose syntaxes that help define the semantic relationships that hold among the words in a sentence. To varying degrees, by constraining the number of relationships in a sentence that must be processed and by identifying the semantic nature of those relationships, these syntaxes increase the efficiency and accuracy of language understanding. Syntactic structure also has an impact on text readability. For instance, sentence complexity, as indicated by sentence length and word frequency, is used as a predictor of readability (Chall, 1958b; Klare, 1974–1975). Text structures, such as topicalization and argument repetition, are also known to affect the ease with which text is understood (Gates & Russell, 1938; Kintsch & van Dijk, 1976; Lesgold, Roth & Curtis, 1976; Smiley, Brown & Oakley, 1975).

What then is the contribution of particular syntactic structures to text readability? Verbs, for example, are thought to be central to sentence understanding. The role they play in language comprehension processes has been treated in some depth in the fields of artificial intelligence and linguistics. However, the impact that verbs have on text comprehension is less well known. This section will review briefly the role that verb structures play in natural language understanding systems and linguistic theory. These theories will then serve as a basis for examining a series of psychological studies that investigates the function of verbs in language comprehension.

Computational theories of natural language conceptualize verbs as elements that are important to both the production and analysis of language. For example, Schank's theory of Conceptual Dependency is a natural language understanding system that attempts to derive consistent semantic representations from different syntactic structures such as paraphrases and cross-language translations (Schank, 1975; Schank & Abelson, 1977). To this end, verb-based information is reduced to a set of conceptual "primitives" that are thought to represent universal state or action concepts. In this system, sentences as such do not have internal representation, but are instead encoded as action-related semantic structures, at the center of which is the verb-based primitive. Other simulation systems contain similar rules that specify the verb as a structure that facilitates the identification of semantic relationships (e.g. Rumelhart & Norman, 1975; Anderson, 1976).

Verb-based information plays an important role in linguistic theory as well. Fillmore (1968), for instance, proposes a case grammar that attempts to modify traditional notions of transformational grammar to accommodate the semantic knowledge that is carried in verb-case relationships (e.g. action-agent, action-

instrument, action-patient relationships). To this end, he proposes a grammar in which the choice of a verb for any given sentence is, to some degree, motivated with reference to the particular case frames associated with that verb (e.g. the verb "throw" takes an agent "the thrower" and an object "that which is thrown"). This suggests that during language production, verb selection is driven by the underlying semantics of what is to be expressed. In turn, the verb is thought to help determine to some extent the organization and content of a linguistic string. Verbs are thought of similarly in more current linguistic theory. For instance, Bresnan's Lexical-Functional Grammar conceptualizes verbs as carrying "atomic" semantic information that guides the composition of sentence structures (Kaplan & Bresnan, 1982).

Although verbs are considered important in language simulation systems and linguistic theory, their role in human language processing has not been fully explored. A limited body of cognitive research has investigated the influence that verb structures have on language comprehension. Evidence from one series of studies (Gentner, 1975, 1978, 1981) suggests that verbs may act as focal points for the integration of semantic information.

Gentner (1981) investigated the role that verbs play in listeners' memory for passage information. Passages were constructed that contained a verb of general meaning (e.g. use, give). In the experimental condition, additional biasing phrases were inserted in order to constrain the interpretation of the general verb to have a more specific meaning (see Table 1 for a sample passage). Gentner found that when listeners heard the inserted, biasing materials, they were more likely to recall a specific verb (e.g. play, sell) than the general verb they had actually heard (e.g. use, give). This suggests that at some point during comprehension, separate elements of information were integrated into a single, semantically-rich structure that was later

recalled as a verb. Gentner hypothesized that verb representations may serve as a loci for the integration of semantic information.

Theoretical work on language comprehension hypothesizes that verb structures are important to processes of sentence understanding. Given this assumption and the evidence that suggests that verbs may act as loci for integration, it is possible that verbs likewise influence text comprehension. A second goal of my research is to determine whether verb structures differentially influence text readability. Of particular interest is whether information carried as a verb will facilitate text comprehension more than that same information carried by another syntactic structure, namely adjectives.

Up to this point, the contribution that two text-based factors make to text comprehension has been the focus of discussion. Factors such as word relationships and surface syntactic structure appear to be capable of affecting both the nature and product of language comprehension. An interactive theory must also consider the effect that reader characteristics have on comprehension. Research investigating expert-novice differences in the domain of reading suggests that an inefficiency in the performance of any one of a number of enabling component skills can be a source of reading difficulty. Because reading is thought to be a multi-component process that is both interactive and hierarchical, the successful operation of one process is thought to rely on the information that is produced by another. Thus, breakdown in a process that enables operation of other, higher level processes can disrupt comprehension. The next section considers the effect that reader ability has on comprehension.

1.4 The Influence of Reader Skill on Text Comprehension

Research investigating the influence that individual reading ability has on text comprehension suggests that comprehension differences may be due, at least in part, to an inefficiency in the performance of certain memory-based processes. Furthermore, this research suggests that these inefficiencies can, in turn, result in the development of compensatory strategies, whose function is to offset a lack of skill, that are useful in only limited textual situations.

1.4.1 Efficiency or automaticity of processing

The efficiency with which each component skill in the complex process of reading is performed is thought to have important implications for the success of comprehension. For example, when a component process like word analysis is performed automatically (without conscious attention), the information that it produces is available for the operation of other processes that are currently underway (e.g. semantic activation). When a lower level skill like word analysis is not automated, performance of other higher level components (e.g. semantic priming, lexical retrieval) may be disrupted because attention must be focused on performance of the lower level skill. Thus, it is hypothesized that the degree to which a critical, enabling process is automated can influence the success of comprehension. The following discussion will consider evidence that demonstrates the effect that inefficiency in a component process can have on ongoing processing. It will additionally consider evidence that suggests that the older, less skilled reader, in an attempt to offset the effect of such inefficiency, may develop compensatory strategies that are useful in only limited conditions. (LaBerge & Samuels, 1976; West & Stanovich, 1978; Posner & Snyder, 1975).

In a previous section, the facilatory interaction that occurs between contextual

sources of information and the letter and featural information in a text were discussed. Recent research suggests that older skilled and older, less skilled readers differ in their use of contextual information. For instance, all readers, regardless of skill, appear to benefit from contexts that tightly constrain a particular word or word meaning. Older less skilled readers, however, appear to depend on context to gain access to a word name or meaning in order to compensate for inefficient decoding skills (Frederiksen, 1978; Perfetti & Roth, 1981; West & Stanovich, 1978; Stanovich, 1980). Because of this dependency, when context is less constraining, these readers must rely on inefficient decoding processes. As a result, word recognition and access to word meaning are penalized (Stanovich & West, 1979; 1981; Frederiksen, 1978). This difficulty is thought to be the result of an interaction between processes of semantic activation and inefficient decoding skills. Thus, while a dependence on contextual information can be helpful in texts of high constraint, it cannot compensate for unskilled decoding in other textual situations.

Given the older, less skilled reader's apparent dependence on context, it is perhaps paradoxical that other research suggests that these readers actually benefit less from contextual information than do skilled readers (Frederiksen, 1978; Frederiksen & Warren, in preparation). For instance, compatible with the findings of West & Stanovich (1978), Frederiksen (1978) found that the word naming ability of all readers benefitted from contexts of high constraint. However, only good readers showed facilitation in contexts of low constraint. Furthermore, the skilled readers showed equal degrees of facilitation for high and low frequency words, regardless of contextual constraint. In contrast, facilitation for the unskilled readers was limited to conditions in which high frequency words occurred in contexts of high constraint. In a separate study, Frederiksen and Warren (in preparation) found that superior readers were able to gain access to both the primary and secondary meanings of ambiguous

words (e.g. "break" meaning "to smash" and "break" meaning "to tame") with equal ease in contexts that highly constrained one of those meanings. Older, less skilled readers, however, experienced difficulty in gaining access to the secondary meanings of these words, even when they were tightly constrained by context. These findings are compatible with work on text readability that shows that it is primarily the less skilled reader who benefits from the presence of high frequency words in a text (Lorge & Chall, 1963; Gates & Russell, 1938; Chall, 1958a).

These results suggest that older, less skilled readers may be penalized not only by inefficient decoding processes but also by inefficiencies in the operation of processes in semantic memory. In skilled readers, semantic activation is thought to be an attention-free, parallel process. The parallel nature of this process makes a wide range of related, relevant concepts available for processing. In contrast, semantic activation in less skilled readers is thought to be an attention-demanding, serial process. The inefficient nature of activation in the less skilled reader is thought to limit the range of concepts activated in memory; that is, because activation operates serially, it does not spread to other appropriate but less strongly associated items. Thus, only words that are highly probable and highly frequent are activated. In this situation, the recognition of high frequency items is facilitated while recognition of less probable or less frequent items is not.

Other research suggests that less skilled readers depend on explicit structural features of text such as a statement of the main idea and the presence of conjunctions to enable comprehension. Similar to the poor reader's dependence on context, a dependence on explicit text structures may represent a compensatory skill developed to offset inefficiencies that exist in processes of semantic analysis (e.g. identifying appropriate antecedent terms, drawing inferential relations, or recognizing

high level relationships such as causality and adversity). (See Marshall & Glock, 1978–1979; Brown & Smiley, 1977; Smiley, Oakey, Worthen, Campione & Brown, 1977; Frederiksen & Warren, in press).

For example, a study by Marshall & Glock (1978–1979) suggests that older, less skilled readers rely on the explicit declarations of the main idea and of high level relations (e.g. as cued by conjunctions and verbs) to aid comprehension. When these features are absent from text, less skilled readers appear unable to use other sources of information to aid comprehension and recall. These findings are compatible with evidence that suggests that beginning readers as well as older, less skilled readers are less sensitive to the relative importance of supporting ideas within a story than are more skilled readers (Brown & Smiley, 1977; Smiley, Oakey, Worthen, Campione & Brown, 1977). These differences may be due to an inability on the part of the beginning reader or the older, less skilled reader to analyze the variety of relationships that hold among the propositions in a text. They may also reflect, in part, an inability to monitor supporting ideas for their relative importance because conscious attention is focused on the execution of inefficient, lower level processes such as decoding and word recognition.

Together, these studies suggest that text comprehension may be affected by the efficiency with which critical skills in reading are performed. These inefficiencies are thought to lead to the development of compensatory strategies whose purpose is to offset inefficient skill performance. Use of these compensatory strategies is not always advantageous, however, as, for example, when their execution depends on the presence of explicit text cues (e.g. rich context clues, statement of main idea, etc.). When such cues are absent from text, the less skilled reader experiences comprehension difficulty.

2. METHOD

This research investigates the influence that word relationships and syntactic class have on the ability of skilled and less skilled readers to analyze implicit semantic relationships in text. The research consisted of two studies: 1) an initial norming study that identified a pool of pairs of entailing and non-entailing words and 2) a study that investigated the influences that entailment and syntactic class have on the inference processes of skilled and less skilled readers.

2.1 Study 1

A norming study was conducted to obtain an out-of-context measure of the degree to which readers judge verbs to semantically obligate associated words. Those words receiving the highest ratings were considered entailing. Ratings for non-entailing words were also collected in order to validate their "lack" of entailment.

2.1.1 Subjects

Twenty skilled readers and twenty less skilled readers from a local high school were paid to participate in this study. No formal tests were administered to determine reading ability. Skilled readers were identified on the basis of their participation in an academically advanced English program and on teacher recommendation. Less skilled readers were identified on the basis of their participation in a remedial reading program and on teacher recommendation. Thus, these subjects represent a range of reading ability.

2.1.2 Materials and Procedure

Two versions of a questionnaire were created that asked subjects to rate the degree to which a verb involved an associated case. An initial pool of verbs (n=68)

judged by the experimenter to be entailing was assembled (e.g., "was murdered"). Each entailing verb was then paired with a semantically similar, non-entailing verb on the following basis: 1) the non-entailing verb represented a more general, or superordinate, exemplar of the semantic domain of the entailing verb (e.g., "died" vs. "was murdered") and 2) the non-entailing verb did not seem to obligate the case role associated with the entailing verb (e.g., "died" does not obligate "killer" whereas "murdered" does).

Readers were asked to rate on a scale from 1 to 9 (1 representing never and 9 representing always) the degree to which each verb always involved its associated case. To ensure that each judgment would be made independently, the questionnaires were created such that an entailing verb and its non-entailing match did not appear in the same version. Each subject saw only one version of the questionnaire.

2.1.3 Results

The mean rating across all subjects for each set of verb-case pairs was calculated and provided a measure for scaling the words along a continuum of entailment. Verb-case sets had to meet two criteria to be eligible for use in the subsequent study: 1) the entailing verb had to receive a mean rating of 6.0 or higher and 2) the non-entailing verb had to receive a mean rating of 4.3 or lower. Forty-five verb sets met these criteria; of these, forty were selected for use in the subsequent study. The set chosen had a mean rating of 7.16 for the entailing verbs and 3.57 for corresponding non-entailing verbs.

2.2 Study 2

This study investigated the influence that entailment and syntactic class have on the ability of skilled and less skilled readers to analyze implicit semantic relationships

in text. Students were asked to read short passages in order to judge whether a final sentence could be true given preceding information in the passage.

2.2.1 Subjects

Thirty-six skilled and less skilled readers from a local high school were paid to participate in this study. Students were selected from a larger pretest pool on the basis of their performance on the Comprehension subtest of the Gates-MacGinitie Reading Test, Level F, Form 2 (MacGinitie, Kamons, Kowlaski, MacGinitie & McKay, 1978). Four ability groups were selected: Group 1 (reading grade level equivalent 12.9 or higher); Group 2 (reading grade level equivalent 11.5-12.5); Group 3 (reading grade level equivalent 8.3-11.2); and Group 4 (reading grade level equivalent 5.2-8.7). There were 9 subjects in each group.

2.2.2 Materials and Design

Forty passages were constructed to manipulate two factors: entailment (entailing, non-entailing) and syntactic class (verb, adjective). Each passage contained three sentences. See Table 2 for a sample passage illustrating each of 4 conditions.

The first sentence included either an entailing word (e.g., The actress was murdered/The murdered actress) or a non-entailing word (e.g., The actress died/The dead actress). The second sentence always introduced a potential antecedent (e.g., Her manager...) for the implicit case entailed by the entailing word (implying, in this example, that the manager could be the killer of the actress). The third and final sentence, to which students made a sensibility judgment, required the reader to connect the information in Sentence 2 with the case implied in Sentence 1. (e.g., The manager is a killer.)

The second manipulation altered the syntactic class in which the entailing or

non-entailing word appeared in Sentence 1. This information appeared as a verb (e.g., The actress was murdered/The actress died) or as an adjective (e.g., The murdered actress/The dead actress).

Thus there were four experimental conditions: 2 levels of entailment (entailing, non-entailing) crossed with 2 categories of syntactic class (verb, adjective). The third variable, reader ability, was used as a grouping factor in subsequent analyses.

Sixty filler passages were also included in order to mask the experimental manipulations. These passages were crafted to vary a) passage length (3 or 4 sentences); b) the sentence in which the entailing/non-entailing word occurred (first or second); and c) whether a "YES" or a "NO" judgment was sensible given preceding passage information. These fillers were included to prevent subjects from adopting comprehension strategies that might affect the experimental results. Table 3 gives a specification of these factors across all passages in the study.

In summary, each student read a total of 100 passages: 40 critical three-sentence passages, 20 filler three-sentence passages and 40 filler four-sentence passages. Conditions were counterbalanced across students and passages and within reader ability groups using a Latin Square design. Passage presentation order for each student was randomly assigned with the exception that the first 8 passages were always fillers in order to provide a period of practice with the display methodology.

2.2.3 Procedure and Apparatus

Each student was run individually for a single session of approximately one hour. Passages were displayed on a video screen using a modified word-at-a-time format presented via an IBM Personal Computer, using a graphics adapter and a USI PI3 amber display monitor. The student's task was to read the sentences in order to

judge, as quickly as possible, whether a final sentence made sense given the preceding passage information.

The initial visual display was of the first sentence of a passage; however, all letters had been replaced by underscores. (See Figure 1 for a sample display.) The student pressed a designated key on the computer keyboard to initiate display of the first word and to call up each subsequent word in a sentence. When the second word appeared, the first word was replaced with underscores. Thus, only one word was visible at a time. All sentences in a passage, except the final one, were presented with this word-at-a-time method. After the last word in the penultimate sentence was displayed, a single long line appeared on the screen. The next button press displayed the final sentence in its entirety and the subject's task was to read and judge its sensibility as quickly as possible. See Figure 1 for an illustration of the display sequence.

This display technique allowed measurement of the reading times for individual words in the initial sentences of a passage, as well as the reading and judgment time of the final sentence. Reading times and sensibility judgments were recorded for each passage.

The technique is an improved version of the Rapid Serial Visual Presentation technique (RSVP; Aaronson & Scarborough, 1976; Juola, Ward, & McNamara, 1982) and has been used to investigate the influences of syntactic and semantic information on comprehension (Schustack, 1982; Haberlandt, 1982; Rosebery, 1983). Just, Carpenter & Woolley (1982) compared the data obtained with this methodology to that obtained from monitored eye movements and found that, while the reading times from the word-at-a-time method are generally inflated, the distribution ratios of reading time to text unit correspond closely in the two methodologies. The methodology used here is a microcomputer-based version developed for this research.

3. RESULTS AND DISCUSSION

3.1 Results

Two dependent variables were of primary interest in Study 2: 1) accuracy rate for judging the plausibility of the final sentence and 2) time consumed in reading and judging the final sentence. Subject and item analyses were carried out for each measure.

To calculate accuracy for each subject within each experimental condition, percent correct was averaged across the 10 critical passages that occurred within a condition. Mean subject per syllable reading times were calculated similarly; however, reading/judgment times were included only for those passages on which subjects made accurate judgments.

To calculate accuracy for each of the critical items within each reader group and experimental condition, percent correct was averaged across the 9 subjects in each reader group. Mean item per syllable reading/judgment times were calculated similarly, again using only the times for those passages on which subjects made accurate judgments.

A series of analyses of variance was performed on these means. Because the results of subject and item analyses did not differ, only the results of the subject analyses are reported in the text of this paper.

3.1.1 Accuracy rate analyses

Table 4 contains the cell means for each of the conditions and reader groups. Main effects of entailment, $F(1,32)=37.41$, $p<.001$, syntactic class, $F(1,32)=4.76$, $p<.037$, and reader ability, $F(3,32)=7.63$, $p<.001$, were significant. All differences between

experimental conditions were in the predicted directions. The accuracy rate of all readers was higher when entailing information was present than when it was not. Likewise, the accuracy rate of all readers was higher when information appeared as a verb than when it appeared as an adjective. Finally, skilled readers were generally more accurate than less skilled readers.

A two-way (Syntactic Class x Reader Group) interaction, $F(3,32)=2.52$, $p<.076$, and the three-way (Entailment x Syntactic Class x Reader Group) interaction, $F(3,32)=2.78$, $p<.057$ approached significance. Examination of the cell means in Table 4 suggests that the accuracy rate of the least skilled readers was more affected by the syntactic manipulation than was the accuracy rate of the other readers (55% in the verb condition vs. 39% in the adjective condition). None of the other interactions was significant, $p>.5$.

3.1.2 Reading/judgment time analyses

Table 5 contains the cell means for each of the conditions and reader groups. Main effect of entailment was significant, $F(1,32)=8.35$, $p<.007$ for the per syllable reading/judgment time of the final sentence. Reading times were shorter in the entailing condition than in the non-entailing condition. A two-way (Entailment x Reader Group) interaction was also significant, $F(3,32)=4.08$, $p<.015$. Examination of the cell means for this interaction reveals that, with the exception of Group 4, all readers were faster in the entailing condition than in the non-entailing condition. Group 4 was slower in the entailing condition than in the non-entailing condition. None of the other main effects nor any of the other interactions were significant, $p>.2$. Although the main effect of reader group was not significant in the reading time analysis, it should be noted that the trend of the data contradict the experimental hypothesis: Group 1 readers had longer reading times than did the other three groups.

3.2 Discussion

Together, these data demonstrate that entailment has a significant effect on both the accuracy and efficiency with which readers of varying ability make text-based inferences. Entailing information improved the accuracy of all readers, regardless of skill. Entailing information likewise improved the efficiency with which readers in Groups 1, 2 and 3 processed passage information. Group 4, the least skilled readers, were less efficient when entailing information was present. Because the effect of entailment was significant for both subject and item analyses, the findings can be generalized to a larger population of readers and to a larger set of texts. The data are interpreted as support for Hypothesis 1, that strong semantic relationships among words facilitate higher order processes involved in inference.

The effects of the syntactic manipulation are less clear. There was a suggestion in the subject analysis that syntactic structure affected accuracy rate; however, no supporting evidence was found in either the reading time analysis for subjects or either of the item analyses. Furthermore, examination of the two-way Syntactic Class x Reader Group interaction suggests that the main effect of syntax on accuracy is principally due to the performance of Group 4 readers (see Table 4). However, given that Group 4 readers were, in general, inaccurate in both conditions, the finding of a significant difference between verb-based and adjective-based information must be interpreted with caution. Thus, strong support was not found for Hypothesis 2, that verbs have a greater facilitory effect on comprehension than adjectives.

The effect of reader skill on inferential processing is also unclear from these analyses. While skilled readers were more accurate in all conditions than less skilled readers, the reading time data suggests that they were, in fact, processing inferences more slowly than less skilled readers. Increased RTs are ambiguous and can be

difficult to interpret. On one hand, they can reflect additional processing that is the result of skill inefficiency, as in the case of poor decoding (cf. LaBerge & Samuels, 1976; Perfetti & Roth, 1981; Stanovich, 1980). On the other hand, increased RTs can reflect skilled processing that is evoked to resolve inconsistencies in the reader's text model that arise during comprehension, as in the case of referent tracing or inferencing (cf. Perfetti, 1979; Frederiksen, 1981b; Frederiksen & Warren, 1985; Craik & Lockhart, 1972). In an attempt to resolve the ambiguity associated with the reading times found in this study, an additional set of analyses was performed on the per syllable reading times of other sections of text in the experimental passages.

3.3 Additional Analyses

Three additional subject ANOVAs were performed on the per syllable reading times for: 1) the manipulated word in the first sentence (e.g., murdered/died); 2) the base part of Sentence 1 (e.g., ... was discovered by her maid late one morning); and 3) Sentence 2 (e.g., She'd met with her manager on the previous night to discuss a new contract). The means used in these analyses were calculated in a manner similar to that described earlier.

3.3.1 Manipulated Word

Table 6 contains the cell means for each of the experimental conditions and reader groups. All main effects and interactions for the per syllable reading time were significant. The main effect of reader skill was significant, $F(3,32)=13.42$, $p<.001$, and differences were in the predicted directions. Reading times of skilled readers were faster than those of less skilled readers. This suggests that when the task involved reading cohesive text, skilled readers processed passage information more efficiently than less skilled readers.

The finding of a significant main effect of entailment, $F(1,32)=33.84$, $p<.001$, is interesting in light of the mean word frequencies for entailing and non-entailing words. Although the mean printed frequency for entailing words was 9 and the mean printed word frequency for non-entailing words was 68 (based on word frequency statistics from the Kucera-Frances Frequency Count, 1967), the mean reading time for entailing words was faster than the mean reading time for non-entailing words (291 msecs vs. 344 msecs). Apparently word frequency does not always represent the ease with which a word will be processed when it appears in connected text.

Finally, main effect of syntactic class was significant, $F(1,32)=16.06$, $p<.001$, as were the Entailment x Syntactic Class interaction, $F(1,32)=64.99$, $p<.001$, the Syntactic Class x Reader Group interaction, $F(3,32)=3.69$, $p<.02$, and the Entailment x Syntactic Class x Reader Group interaction, $F(3,32)=23.0$, $p<.001$. Referring to Table 6, the cell means for the main effect of syntax suggest that verbs were processed faster than adjectives. However, close examination of the cell means themselves suggests that the significant effect is due to faster reading times in the Entailment x Verb condition. This suggests that, in combination, the semantic and syntactic information provided in the entailing/verb condition had a strong facilitory effect on processing.

3.3.2 Base Part of Sentence 1

Table 7 contains the cell means for each of the experimental conditions and reader groups. None of the variables had a main effect on the reading time per syllable for the base part of Sentence 1 that was common to all experimental versions of a passage, $p>.24$. However, the Entailment x Reader Group interaction, $F(3,32)=2.40$, $p=.07$ and the Syntactic Class x Reader Group interaction, $F(3,32)=2.54$, $p=.08$, approached significance. Figures 2 and 3 illustrate these interactions and suggest that the effects are due to the performance of Group 4. The

times of these readers are much slower in the entailing condition than in the non-entailing condition, and much slower in the verb condition than in the adjective condition. These data, together with the data that show that Group 4 readers were accurate only when entailing information appeared as a verb, have interesting implications for the nature of processing in the less skilled reader. The results suggest that when processes of semantic analysis and integration are supported by explicit text information (e.g., entailments and verb structures) the less skilled reader is able to construct a text model that permits inferential processing. But, when such structures are absent, less skilled readers can experience comprehension difficulty.

3.3.3 Sentence 2

None of the main effects nor any of the interactions on the reading time per syllable for Sentence 2 were significant, $p>.18$. This suggests that (1) the second sentence was relatively neutral with respect to task demands and (2) the methodology itself did not affect processing significantly.

3.4 Discussion

The results of these additional analyses, in combination with the accuracy rate and reading/judgment time data for the final sentence, suggest that the profile of the skilled reader is complex. On one hand, the reading times for the manipulated word and the base part of Sentence 1 demonstrate that skilled readers processed Sentence 1 information faster than less skilled readers. On the other hand, the reading/judgment time data for the final sentence suggest that skilled readers processed the action-case inference more slowly than less skilled readers. This could suggest that skilled readers were less able than less skilled readers to make the action-case inference. However, such a conclusion is not supported by the accuracy data: skilled readers were significantly more accurate than less skilled readers in all

experimental conditions. It may be the case, then, that skilled reading is not always characterized by speed of processing. Text situations may exist that, in fact, cause skilled readers to increase their processing time. In order to address this hypothesis, let us examine the effects that the particular textual situations present in the experimental passages may have had on processing and comprehension.

Consider first the processing that occurs during comprehension of Sentence 1 information. Here, the reader's principal task is to comprehend explicit information. This requires that the reader analyze the relationships that hold among Sentence 1 propositions and integrate them into a coherent text model. Because the first sentence consists of cohesive and well-structured text, processing can proceed in a straightforward manner.

Consider now the processing that occurs during comprehension of the final sentence. Here, the reader's task is more complex. First, the reader must analyze the relationships that exist among the explicit arguments that are present in the final sentence. Second, in order to integrate final sentence information into the text model, the reader must infer the relationship that exists between the explicit case (e.g., killer) and its associated action (e.g., was murdered/died). Because a referent for killer is not explicit, this inference is complex. The reader must identify an appropriate antecedent for the associated case (e.g., manager) and then construct a bridging relationship to connect the associated case to the referent (e.g., killer to manager). Finally, the reader must judge the plausibility of the final sentence. Thus, in the final sentence where the text is less cohesive, success in comprehending is a function of success in making the required connections.

With these differences in mind, let us re-examine the reading time performances of skilled and less skilled readers. As discussed previously, Group 1 readers had

faster Sentence 1 reading times than did the other reader groups. Furthermore, the speed with which Group 1 readers processed the common part of Sentence 1 was unaffected by experimental manipulation (e.g., substitution of died for murdered and dead for died). This suggests that the skilled readers comprehended cohesive text accurately and efficiently. However, when these readers had to read and judge the plausibility of the less cohesive text in the final sentence, their processing profiles changed dramatically: reading/judgment times increased to the extent that they became the slowest of the reader groups.

The accuracy data suggest an explanation for why this occurs. Group 1 readers were the only readers who maintained high rates of accuracy across all four experimental conditions. The accuracy rates of the other reader groups depended, to varying degrees, on experimental condition. Thus, it is possible that, instead of reflecting processing inefficiency, increased reading/judgment times reflect additional analyses evoked to counteract the influence of less cohesive text. This additional semantic analysis, while consuming more time, may, in fact, have allowed Group 1 readers to construct coherent text models regardless of experimental condition. This conclusion is supported by the large reading/judgment time difference between the entailing (607 msecs) and non-entailing (810 msecs) conditions observed for Group 1. The longer times in the non-entailing condition may reflect additional semantic analysis, evoked to offset the influence of the less cohesive text. To summarize, the data for Group 1 suggest that skilled readers routinely process text in a thorough and efficient manner. When these readers are faced with less cohesive text, they engage in additional semantic analysis that enables them to continue to make sense out of what they read. This conclusion is compatible with work that suggests that, in the service of comprehension, readers process text at a variety of levels of analysis, and that at deeper levels, efficiency of processing may not be a factor critical to success

(Frederiksen & Warren, 1985; Perfetti, 1979; Craik & Lockhart, 1972). This ability, often referred to as flexibility of rate, is characteristic of skilled reading (Chall, 1983; Harris & Sipay, 1975).

A strikingly different profile is indicated for Group 4, the least skilled readers. Not only does it appear that Group 4 readers comprehend Sentence 1 information differently than do Group 1 readers, but it appears that these differences may also affect comprehension of later-occurring passage information.

Consider first the accuracy data of Group 4. These readers were accurate in the entailing/verb condition only. This suggests that only when an entailing/verb structure was present were the Group 4 readers able to make the necessary action-case inference. The reading time data support this position. For Group 4 readers, the reading times of the base part of Sentence 1 were significantly longer in the entailing/verb condition than they were in the other conditions. Thus, when an entailing verb structure was present, Group 4 readers seemed to engage in additional analyses of Sentence 1 information. None of the other reader groups were affected by the experimental manipulations. In combination with the accuracy results, therefore, the reading time data suggest that Group 4 readers constructed more coherent models of Sentence 1 information in the entailing/verb condition than they did in the other 3 conditions.

The final sentence reading/judgment time data add additional support to this characterization of the Group 4 reader. Although the least skilled readers were most accurate in the entailing/verb condition, the reading/judgment times of these readers were slower in this condition than in any of the other conditions. (Recall that the other three reader groups were fastest in the entailing/verb condition.) This suggests that, rather than experiencing facilitation in processing as a result of the

entailing/verb structure, Group 4 readers engaged in additional processing when this structure was present.

As in the case of the Group 1 readers, the accuracy data and the reading time data of Group 4 suggest that text information influenced the thoroughness with which readers comprehended passage information. However, in the case of Group 4 readers, only when the entailing-verb structure was present were they able to construct text models that supported integration of final sentence information with preceding passage information.

In summary, this comparison between the most skilled and the least skilled readers suggests that text-based information affects not only the efficiency of accurate comprehension, but also the nature of processing required to comprehend accurately. When text is cohesive (i.e., semantic relationships in a text are explicit), skilled readers process text accurately and efficiently. When text is less cohesive, however, skilled readers engage in additional semantic analysis in order to make sense out of the text. These additional analyses in turn increase reading time. Less skilled readers, however, appear to be successful in comprehending text only when cues such as entailments make it cohesive. In addition, less skilled readers are less efficient at processing explicit relationships than are skilled readers. Finally, when explicit cues are absent from text, less skilled readers become less accurate in comprehending than skilled readers.

3.5 Vocabulary Analyses

Why do less skilled readers have difficulty understanding explicit and implicit semantic relationships in text? One reason may be that they have a poorer understanding of the words (and the concepts the words represent) than do skilled

readers. The correlation between vocabulary knowledge and reading comprehension is well known: students who score high on tests of vocabulary typically perform better on tests of reading comprehension than students who score low (Carroll, 1971; Davis, 1968; Terman, 1918, Chall, 1983; Chall & Snow, 1982). Although this correlation does not imply causality, the student who is unfamiliar with the meanings of many of the words in text is likely to experience comprehension difficulty (Chall, 1983; Freebody & Anderson, 1981; Thorndike, 1973-1974).

To investigate the extent to which differences in word knowledge may have influenced comprehension, a final set of analyses was performed on the accuracy and reading/judgment time data. Toward this end, a vocabulary test was created in the following way. Using the Dale-O'Rourke Living Vocabulary (Dale & O'Rourke, 1976), each entailing, non-entailing and associated case word used in the experimental passages that was found to be known by less than 75% of fourth graders was included in the vocabulary test. There were 60 such items. Two versions of a 30-item test were created such that (a) an entailing word and its associated case did not appear together and (b) the mean word frequency of the two versions was approximately equal. For each item, students had to choose the word or phrase that was closest in meaning to the test word. Thus, this test assessed whether or not a student possessed any knowledge of a word and not the depth or precision of that knowledge (Lorge & Chall, 1963). Students were tested individually following completion of the experimental task. Versions were counterbalanced across and within reader skill groups.

3.5.1 Results

The mean accuracy rate on the vocabulary test across all skill groups was 85%. Individual reader group scores were 92%, 91%, 82%, and 74% for Groups 1 to 4,

respectively. An analysis of variance indicated that there were significant differences in vocabulary knowledge among reader skill groups, $F(3,32)=6.26$, $p<.002$. Thus, it appears that vocabulary knowledge may have contributed to performance differences in the experimental task.

In an attempt to examine reader group differences, the individual vocabulary score of each reader was coded by skill group and plotted on a graph (see Figure 4). Examination of this figure shows that the readers in Group 4 fall into two vocabulary ability groups: a group of 6 students whose performance on the vocabulary test resembles that of the other students (average accuracy rate of 84%) and a group of 3 students whose performance is clearly below that of the other readers (average accuracy rate of 56%). A t-test on the vocabulary scores of these two Group 4 subgroups confirmed that the differences in vocabulary accuracy were significant, $t(6)=6.44$, $p=.0005$.

Further analyses were performed to determine whether these within-Group 4 differences were correlated with other performance measures. For example, a t-test comparing accuracy rate on the experimental task for the two Group 4 subgroups was significant (56% vs. 32%), $t(6)=2.38$, $p=.03$. A correlation between accuracy rate on the vocabulary test and accuracy rate on the experimental task for all 36 subjects suggests that the relationship between the two variables is significant, $r=.68$, $p<.01$.

These results carry implications for the role that vocabulary and verbal knowledge play in reading comprehension. First, it is clear that, for 3 of the students in Group 4, an unfamiliarity with some of the crucial vocabulary may have contributed to comprehension difficulty. This finding is consistent with other research that demonstrates the high correlation between vocabulary knowledge and reading achievement (Chall, 1983; Chall & Snow, 1982; Davis, 1968; Anderson & Freebody, 1981;

Thorndike, 1973-1974). A second, less understood influence of vocabulary may also be in operation, however. Six of the students in Group 4 demonstrated a knowledge of the crucial vocabulary that was similar to that of the other three groups. These students, however, still experienced significant comprehension difficulty. This suggests that, although they were familiar enough with the vocabulary to be accurate on a test of isolated meaning recognition, they may have experienced difficulty in using that knowledge during text comprehension. This is consistent with research that suggests that differences exist among individuals in how well or how completely word meanings are understood, and further, that differences in the completeness or precision of word knowledge can influence reading comprehension (see Curtis, Collins, Gitomer, & Glaser, 1983; Gitomer & Curtis, 1983; Beck, Perfetti,& McKeown, 1982).

On the basis of the significant correlation between vocabulary knowledge and the experimental task, a final set of analyses was performed in which students were ranked according to their vocabulary scores. The student with the highest score received a ranking of 1 and the student with the lowest score received a ranking of 36, and four vocabulary groups of 9 students each were formed on the basis of these rankings. When students from different reader ability groups had tie scores, they were placed in vocabulary knowledge groups so as to balance the distribution of readers from differing ability groups. The mean vocabulary score for each of these groups was 96%, 92%, 84% and 68%, Groups I to 4, respectively. An analysis of variance using vocabulary knowledge as a grouping factor was then performed on the mean accuracy data and the mean reading/judgment time data for the experimental task.

3.5.2 Accuracy rate

Table 8 contains the cell means for each condition and vocabulary group. Main effects of vocabulary knowledge, $F(3,32)=3.1$, $p=.04$, entailment, $F(1,32)=37.44$, $p<.001$,

and syntactic class, $F(1,32)=4.12$, $p=.05$ were significant. The Vocabulary Knowledge x Entailment x Syntactic Class interaction approached significance, $F(3,32)=2.67$, $p=.06$. None of the other effects was significant, $p>.53$. The results of this analysis are similar to those obtained when ability groups were determined by scores on the Gates-MacGinitie Comprehension subtest (compare Tables 4 and 8). This suggests that the Gates-MacGinitie Comprehension subtest and the vocabulary test constructed for this experiment are correlated.

3.5.3 Reading/judgment time

Table 9 contains the cell means for each condition and vocabulary group. Main effects of vocabulary knowledge, $F(3,32)=9.35$, $p<.001$, entailment, $F(1,32)=26.62$, $p<.001$, and syntactic class, $F(1,32)=13.08$, $p<.001$, were significant. The Entailment x Syntactic Class interaction was significant, $F(1,32)=26.48$, $p<.001$, as was the Vocabulary Knowledge x Entailment x Syntactic Class interaction, $F(3,32)=3.03$, $p=.04$. None of the other interactions was significant, $p>.41$.

These results differ from those obtained in analyses in which Gates-MacGinitie Comprehension subtest scores were used to determine ability groups (compare Tables 5 and 9). Most interesting is the finding of a significant difference in reading/judgment time between vocabulary groups. Differences between vocabulary knowledge groups were in the direction predicted by Hypothesis 3: "high knowledge" groups processed final sentence information faster than "low knowledge" groups. In contrast, reader skill as determined by Gates-MacGinitie scores did not have a significant main effect on reading/judgment time. This suggests that vocabulary knowledge may influence both the thoroughness and efficiency with which text is understood.

The results of this second set of analyses suggest that vocabulary knowledge can

influence reading comprehension in powerful and complex ways. While the findings are compatible with research that demonstrates that vocabulary knowledge is highly correlated with reading ability (Chall, 1983; Davis, 1968; Freebody & Anderson, 1981; Thorndike, 1973-1974), they suggest that the relationship between vocabulary knowledge and text comprehension is not a simple one.

In summary, these analyses support Hypothesis 3, that skilled and less skilled readers are distinguished by the degree to which processes of integration and inference are facilitated by semantic and syntactic sources of information. In general, skilled readers were found to be more accurate at judging the plausibility of a statement that required an action-case inference than were less skilled readers. Evidence for this superiority was found both within and across experimental conditions. Further, when ability was determined by vocabulary knowledge, "high knowledge" students were both faster and more accurate at the experimental task than were "low knowledge" students. Finally, evidence was found to suggest that less skilled readers may depend on text-based cues such as entailing/verb structures to enable integration and inference.

4. IMPLICATIONS FOR A TEXT PROCESSING MODEL

The motivation behind this research was to investigate the interactions that occur between reader skill and the text characteristics of entailment and surface syntax during text comprehension. In order to specify their effect on comprehension, the results of Study 2 will be considered within an interactive model of reading (Kintsch & van Dijk, 1978; Foss, 1982; Frederiksen & Warren, in press).

Models of discourse processing propose that the propositions in a text are organized in a hierarchical structure that reflects (1) the repetition of ideas or

arguments and (2) the relative importance of the propositions with respect to a text's central theme. A proposition is considered to be at a "high" level within the hierarchy if it provides a base to which other, newly-encountered propositions can be attached or integrated. Thus, text comprehension is viewed as a series of processes in which a reader integrates newly-encountered information with information already present in memory (Kintsch & van Dijk, 1978; Foss, 1982; Frederiksen & Warren, in press).

4.1 Effects of Entailment/Reader Skill Interactions on Text Comprehension

The results of Study 2 demonstrate that texts that contain entailing words are easier for all readers to comprehend than texts that do not contain such words. This section will consider the implications that the entailment effect has for a model of text comprehension.

Entailing words are a subset of words of high association. That is, an entailing phrase such as "was murdered" is thought to be strongly associated with its related case words, e.g. "killer", "victim", "weapon", etc. According to theories of semantic memory, recognition of a word facilitates recognition of other closely related words (Collins & Loftus, 1975). These theories propose that the organization of concepts in semantic memory and the processes that operate on those concepts contribute to the facilatory effect. Research has demonstrated this effect to be powerful when subjects are asked to comprehend sentences (Fischler & Bloom, 1978; West & Stanovich, 1978; Frederiksen, 1978) as well as recognize single words (Meyer, et al. 1973). Other research suggests that semantic memory can influence the processes involved in understanding extended text (Foss, 1982; Rosebery, 1982). The results of Study 2 confirm this earlier work and permit speculation on (1) the locus of the facilatory effect and (2) the processes which underlie it.

Two alternate interpretations of the nature of the facilitation that results from entailments are possible. In both, facilitation is thought to be the consequence of influences in semantic memory. However, the interpretations differ in the locus of the effect and the processes proposed to account for it.

4.1.1 Semantic activation

The first interpretation proposes that the influence of entailment is felt only at that moment during comprehension when the word "killer" is processed. To illustrate, let us refer to the "actress" passage in Table 2. Because the first two sentences in the passage are cohesive, they will be processed relatively easily. The final sentence poses a problem of reference to the reader, however. Although "killer" is explicitly connected to "manager" in the final sentence, it has no direct antecedent in the reader's text model. This inconsistency evokes a search process in which "killer" is compared to information that is current in the text model. In the entailing condition, consideration of "was murdered" sets in motion a series of processes operating in semantic memory that, in turn, enable recognition of the conceptual relationship linking "was murdered" and "killer". As a result, the strong semantic relationship between "killer" and "was murdered" is eventually recognized and a basis for the integration of "killer" into the text model is provided.

The weaker semantic relationship that exists between "died" and "killer" in the non-entailing condition cannot facilitate comprehension in the same way, however. The lack of entailing information will result in either of two possible processing consequences: (1) additional analyses will be performed in order to connect "killer" to "died" (causing an increase in processing time) and, as a result, an antecedent for "killer" will be identified or (2) the search for an appropriate antecedent will fail and comprehension will break down. In sum, the semantic activation hypothesis states that

the facilitation that results from an entailing word (1) is caused by processes in semantic memory and (2) occurs during search processes that are evoked to resolve an inconsistency in the reader's text model.

4.1.2 Case completion

The second interpretation is derived from linguistic theory and work in natural language (Fillmore, 1968; Bresnan & Kaplan, 1982; Schank, 1972) and hypothesizes that the obligatory relationship that holds between an entailing word and its associated case motivates a series of anticipatory processes that facilitate the case-action inference. Specifically, this interpretation hypothesizes that recognition of the entailment sets up the expectation that its associated case role(s) will be encountered. That is to say, at the time the reader processes the phrase "was murdered", an empty slot is established in the text model for the missing, entailed case, "killer". As a result, when "manager" is explicity identified as "the killer" in the final sentence, the slot is filled and the inference readily completed. In this interpretation, facilitation (1) is the result of processes in semantic memory and (2) occurs at the time the entailing word is processed in anticipation of the missing case role.

The second interpretation has some difficulty accounting for processing that occurs in the non-entailing condition. Because the action "died" does not obligate the presence of "killer", the reader cannot be led in advance to establish an empty slot in the text model. As a result, the inference between "manager" and "killer" can be made only at the time the reader becomes aware of an inconsistency. In this situation, processing would likely proceed in a manner similar to that described in the semantic activation hypothesis.

The performance differences demonstrated by the skilled and less skilled readers

support both interpretations. Skilled readers, in whom processes based in semantic memory and processes of semantic analysis are thought to operate automatically, are relatively accurate across conditions. The expertise with which these processes operate not only increases the speed of the skilled readers' performance in the entailing condition, but it enables them to be accurate in the non-entailing condition as well. In contrast, less skilled readers are accurate only when entailing information is present in a passage. For these readers, processes based in semantic memory and processes of semantic analysis are thought to operate in an attention-demanding, serial manner (West & Stanovich, 1978; Frederiksen, Warren & Rosebery, 1985; Frederiksen & Warren, 1985). As a result, less skilled readers make the action-case inference only when the entailment is explicit in text.

Although the results of Study 2 do not compel acceptance of one interpretation over the other, evidence from other studies sheds some light on the problem (Haviland & Clark, 1974; Singer, 1979, 1980; Lesgold, Roth & Curtis, 1978; Carpenter & Just, 1978). These studies suggest that readers do not routinely engage in the kind of advance or forward inferencing put forward in case grammar theories and natural language systems. This work suggests that readers engage in inferencing only at moments in comprehension when an inconsistency arises. Further, these studies suggest that, instead of inferring in advance in anticipation of additional information, readers apparently reconsider previously understood information in order to resolve inconsistencies. In combination, this evidence suggests that the first interpretation may be a more powerful model for the data because (1) it proposes a single process to account for the effects of both entailing and non-entailing information and (2) it is consistent with other research on inferencing.

4.2 The Effects of Syntax/Reader Skill Interactions on Text Comprehension

The influence that syntactic structure has on comprehension is less clear from the data obtained in Study 2. Although the results demonstrate that syntactic structure alone does not appear to influence processing, they suggest that in interaction with (1) processes originating in semantic memory and (2) reader skill, syntactic structure may be capable of facilitating integration and inference. This section will speculate briefly on the role that syntactic structure may play in text processing.

As discussed previously, information is thought to be kept active in memory in systematic ways. One factor that is thought to help determine the status in memory of an argument is the likelihood that it will serve as a basis for integration. Arguments that serve such a function are thought to be placed at a relatively "high" level within a text model. It is possible that syntactic class may serve as an initial indicator of the relative importance of an argument within a text's heirarchical structure. As a result, syntactic class may influence, to some extent, the level at which a proposition is placed within a reader's text model. For instance, a verb structure may indicate that an argument has a high likelihood of being important for integration while an adjective structure may indicate that an argument is less likely to be important for integration. As a result, verb structures may be placed at high and relatively central positions within a text model in a routine fashion and adjective structures may be placed in less central positions. Syntactic structure is not an exclusive indicator of importance, however; semantic analysis is thought to be the basis of text comprehension. Thus, while syntactic structure may serve as a preliminary indicator of the relative importance of an argument, and as such facilitate ongoing processing, processes of semantic analysis are thought to be the final determinant of a text's representation.

Although the results of Study 2 can, at best, be considered preliminary evidence, they allow us to speculate about the interactions that occur between syntactic structure and reader skill. In the case of the skilled readers, the results suggest that although these readers were able to draw inferences accurately in all conditions, they required significantly more time to process inferences in the adjective condition. The increase in time suggests that skilled readers engaged in additional processing in order to complete the inference in the adjective condition. The performance of the other reader groups depended to varying degrees on the presence of verb structures. For instance, the least skilled readers were accurate only when "murdered" appeared as a verb. It is possible, that, by providing essential information about the relative importance of the argument, the verb structure enabled less skilled readers to construct text models that facilitated the action-case inference. Although the results clearly demonstrate that less skilled readers could not perform this task in the adjective condition, the actual source of this difficulty remains unknown. Thus, while this study suggests that the less skilled reader may benefit when important information is encoded as a verb, the evidence is not conclusive.

5. INSTRUCTIONAL IMPLICATIONS

The results of this research suggest that the comprehension processes of older, less skilled readers may be penalized by both process-based and knowledge-based sources of difficulty. Study 2 suggests that these readers may differ from skilled readers in 1) the success with which processes involved in semantic analysis operate and 2) the organization and content of verbal knowledge. This final chapter will consider some implications this research has for improving the comprehension skills of older, less skilled readers.

5.1 Process-Based Differences

This study suggests that older, less skilled readers may experience comprehension difficulties because they lack skill in analyzing the semantic relationships present in text. For example, in Study 2, less skilled readers had difficulty drawing action-case inferences. It is possible that a lack of expertise in certain processes involved in semantic analysis affected their comprehension of text. For example, the less skilled reader is thought to differ from the skilled reader in the efficiency with which processes in semantic memory (such as semantic priming and lexical access) operate (Frederiksen & Warren, 1985; Stanovich, 1980). To be specific, skilled readers are thought to gain access readily to a wide range of concepts and associated words. Furthermore, the range of words to which skilled readers have access appears to be independent of typicality of meaning and printed word frequency. In contrast, less skilled readers are thought to gain access to only a small range of concepts and associated words. Additionally, the words available to less skilled readers seems to be limited to those of high frequency that typically occur in a given context (Frederiksen, 1978).

Computer-based instruction has been designed to address these process-based differences (Frederiksen, Warren & Rosebery, 1985). The aim of the software is to develop processes involved in semantic priming and lexical access to levels of effortless performance, or automaticity. Although the program has been tested with only a small sample of unskilled high school readers, the results of the evaluation suggest that these students learned to use the information present in context to recognize and comprehend low frequency words as easily as high frequency words.

Less skilled readers may also experience difficulty in comprehending text because they are less able to monitor for and recognize inconsistencies that occur during text

comprehension. Work by Brown (1980) has shown that skilled readers routinely monitor their understanding of a text for inconsistency. Further, when an inconsistency in comprehension arises, skilled readers are able to 1) trace the cause of the inconsistency, and 2) engage in processing that will resolve it (i.e. rereading, inferencing). In contrast, less skilled readers appear to be penalized doubly for their lack of monitoring skill. First, comprehension is less thorough because less skilled readers are unaware of inconsistency, and thus construct less well-integrated models of a text's meaning. Second, even when these readers are aware of inconsistency, they are less able to trace its cause.

In Study 2, less skilled readers were less accurate than skilled readers in judging the plausibility of the final sentence. A lack of skill in comprehension monitoring may have contributed to this inaccuracy. If, in the experimental passages, less skilled readers were not sensitive to missing information such as an antecedent for "killer", it is likely that they would not recognize the need for inferencing and thus would not infer the action-case relationship between "was murdered" and "killer". This would, of course, affect their ability to judge the final sentence as plausible.

While this conclusion fits the data, implications for instruction are not obvious. Although less skilled readers may be less able to monitor comprehension and resolve inconsistency, the underlying source of this difficulty has not been identified clearly. On one hand, it is possible that these readers need explicit instruction in monitoring for and tracing inconsistency. In this case, instruction in these processes would improve comprehension. Research in this area is not conclusive. While Palincsar & Brown (1984) found training in metacomprehension to be effective, Paris & Jacobs (1984) did not find strong evidence for transfer to other comprehension instruments.

On the other hand, it is possible that, because less skilled readers are attending to the performance of other, more immediate processes (e.g. decoding, accessing the meaning of a word, understanding a sentence context), they may be unable to attend to monitoring. In this case, improvement must take place in the performance of the other, more immediate processes before an improvement in monitoring and comprehension will occur.

5.2 Knowledge-Based Differences

Study 2 suggests that vocabulary knowledge influences comprehension in powerful and complex ways. The results are compatible with the body of research that demonstrates that vocabulary knowledge is highly correlated with reading ability (Chall & Snow, 1982; Stahl, 1982; Davis, 1968; Thorndike, 1973-1974; Freebody & Anderson, 1981). Furthermore, they provide some clues about the nature of verbal knowledge, its acquisition, and the role it may play in text comprehension.

First, the comprehension of some of the least skilled readers appeared to be penalized by an unfamiliarity with some of the critical vocabulary, as demonstrated by an inability to recognize a synonymous word or phrase for the critical words on the vocabulary test. That these students experienced comprehension difficulties is not surprising. It is well known that word recognition and knowledge of word meanings are essential components of text comprehension (Chall, 1983; Davis, 1968; Freebody & Anderson, 1981).

Second, there was evidence that other less skilled readers, who appeared to be knowledgeable about the critical vocabulary, were not able to use it in the service of comprehension. Although these students knew the critical words well enough to be accurate on the vocabulary test created for this study, they were unable to use

knowledge of these words to make inferences during text comprehension. This finding suggests that knowing a word may not be a simple "have" or "have not" condition and it is compatible with research on vocabulary instruction and word knowledge that suggests that acquisition of word meanings is developmental in nature (Chall & Snow, 1982; Lorge & Chall, 1938; Dale, O'Rourke, & Bamman, 1971). This research demonstrates that stages of word understanding can range from unfamiliarity, to recognition of a word in its most typical context, to recognition of an appropriate definition for a word out of context, to use of subtle and specific word knowledge to enhance text comprehension.

The findings of Study 2 are also compatible with evidence from research on individual differences in verbal knowledge (Curtis, Collins, Gitomer & Glaser, 1983; Gitomer & Curtis, 1983). This work demonstrates that "high" and "low" verbal college students differ in the degree to which word knowledge is understood abstractly. That is, word knowledge in "high" verbal students may be organized according to abstract semantic relationships while word knowledge in "low" verbal students may be tied to information associated with the specific contextual situations in which a given word typically appears.

Together with previous research, the results of Study 2 suggest that word understanding evolves through several stages of complexity or precision before it is maximally useful during text comprehension. While the findings of the present research do not have specific implications for the design of instruction, they underscore the importance that a deep understanding of words has in the high level inferential processes involved in comprehension. Thus, one consequence of the present research is to raise additional questions about (1) the kinds of knowledge that characterize the different stages of development in word understanding and (2) the

effect that these differences in word knowledge may have on text comprehension. The answers to these questions may, in turn, carry direct implications for instruction.

Table 1

Sample passage from Gentner, 1981

Rosemary Kartovsky was pleased when the Chicago Symphony hired her away from the Boston Pops. She figured she could move everything in her camper, but first she had to go through her things and throw out the unnecesary items.

Two beat-up violins, an upright piano and a plastic flute went.

If she hadn't (used) it in the last year it had to go. Fortunately, she had some friends who were glad to get her castoffs. She (gave) them the things she couldn't use.

This way she made just enough money to pay for the gas for her trip.

The only thing that made her sad was parting with her toucan. She was used to hearing him sing along with her when she practiced.

As she drove out of the city limits, still reminding herself that it was for the best and that birds hate long trips, she heard a familiar croaking behind her. Sure enough, her pals had smuggled in the bird, and now she suddenly felt a hundred times better about life in Chicago.

Note: Parentheses denote critical verbs. Boxing denotes material inserted in the experimental condition. The predictions for the experimental groups are: used → played
gave → sold

Table 2

Sample experimental passage

First Sentence

Entailing/Verb	The actress was murdered and	was discovered by her maid late one morning.
Non-entailing/Verb	The actress died	and was discovered by her maid late one morning.
Entailing/Adjective	The murdered actress	was discovered by her maid late one morning.
Non-entailing/Adjective	The dead actress	was discovered by her maid late one morning.

Second Sentence

She'd met with her manager on the previous night to discuss a new contract.

Third Sentence

The manager is a killer.

Table 3

Distribution of experimental manipulations
across 100 passages

	Criticals (n=40)	Fillers (n=60)
Entailing	20	41
Non-entailing	20	19
3 sentences in passage	40	20
4 sentences in passage	—	40
Entailing/Non-entailing word in first sentence	40	15
Entailing/Non-entailing word in second sentence	—	45
"YES" response is correct	40	20
"NO" response is correct	—	40

Table 4

Mean percent correct
(subject anaysis)

		READER SKILL GROUP				ROW MEAN	
		1	2	3	4		
ENTAILING	VERB	79	77	68	63	E x V 72	ENTAILING MEAN = 69
	ADJ	76	82	64	43	E x A 66	NON-ENTAILING MEAN = 55
NON-ENTAILING	VERB	68	68	46	48	NON-E x V 58	VERB MEAN = 65
	ADJ	64	52	54	36	NON-E x A 52	ADJECTIVE MEAN = 59
	READER GROUP MEAN	72	70	58	48		

Table 5

Mean reading/judgment time per syllable for final sentence
(subject analysis)

		READER SKILL GROUP				ROW MEAN	
		1	2	3	4		
ENTAILING	VERB	593	393	665	657	E x V 577	ENTAILING MEAN = 561
	ADJ	621	508	582	469	E x A 545	NON-ENTAILING MEAN = 639
NON-ENTAILING	VERB	942	474	731	504	NON-E x V 663	VERB MEAN = 620
	ADJ	680	568	711	501	NON-E x A 615	ADJECTIVE MEAN = 580
	READER GROUP MEAN	709	485	672	532		

Table 6

Mean reading/judgment time per syllable manipulated word

		READER SKILL GROUP				ROW MEAN	
		1	2	3	4		
ENTAILING	VERB	231	216	272	243	E x V 240	ENTAILING MEAN = 291
	ADJ	278	310	377	401	E x A 341	NON-ENTAILING MEAN = 344
NON-ENTAILING	VERB	292	284	336	496	NON-E x V 352	VERB MEAN = 296
	ADJ	292	378	335	338	NON-E x A 335	ADJECTIVE MEAN = 339
	READER GROUP	273	297	339	370		

Table 7

Mean reading time per syllable

base part of sentence one

		READER SKILL GROUP 1	2	3	4	ROW MEAN	
ENTAILING	VERB	269	257	237	351	E x V 279	ENTAILING MEAN = 278
	ADJ	255	282	256	309	E x A 276	NON-ENTAILING MEAN = 260
NON-ENTAILING	VERB	276	261	221	287	NON-E x V 261	VERB MEAN = 270
	ADJ	264	290	252	232	NON-E x A 260	ADJECTIVE MEAN = 268
	READER GROUP MEAN	266	273	242	295		

Table 8

Mean percent correct on experimental task

vocabulary knowledge groups

		READER SKILL GROUP				ROW MEAN	
		1	2	3	4		
ENTAILING	VERB	79	73	68	67	E x V 72	ENTAILING MEAN = 69
	ADJ	78	77	54	57	E x A 67	NON-ENTAILING MEAN = 55
NON-ENTAILING	VERB	61	68	41	59	NON-E x V 57	VERB MEAN = 65
	ADJ	58	57	48	44	NON-E x A 52	ADJECTIVE MEAN = 59
	READER GROUP M	69	69	53	57		

Table 9

Mean reading/judgment time per syllable experimental task

vocabulary knowledge groups

		READER SKILL GROUP				ROW MEAN	
		1	2	3	4		
ENTAILING	VERB	205	234	253	270	E x V 241	ENTAILING MEAN = 291
	ADJ	277	316	396	378	E x A 342	NON-ENTAILING MEAN = 314
NON-ENTAILING	VERB	312	285	384	427	NON-E x V 352	VERB MEAN = 297
	ADJ	320	330	352	341	NON-E x A 336	ADJECTIVE MEAN = 339
	READER GROUP MEAN	279	291	346	354		

Display 1

__ _____ __ _____ __ __ _____ _ __ __ __ __ _____

Display 2

The _____ __ _____ __ __ _____ _ __ __ __ __ _____

Display 3

__ actress __ _____ __ __ _____ _ __ __ __ __ _____

Display 4

__ _____ was _____ __ __ _____ _ __ __ __ __ _____

Display 5

__ _____ __ murdered __ __ _____ _ __ __ __ __ _____

Display 6

__ _____ __ _____ and ___ _____ _ __ __ __ __ _____

Display 7

__ _____ __ _____ was _____ _ __ __ __ __ _____

Display 8

__ _____ __ _____ __ __ discovered _ __ __ __ __ _____

Figure 1. Illustration of word-at-a-time sequence for sample passage.

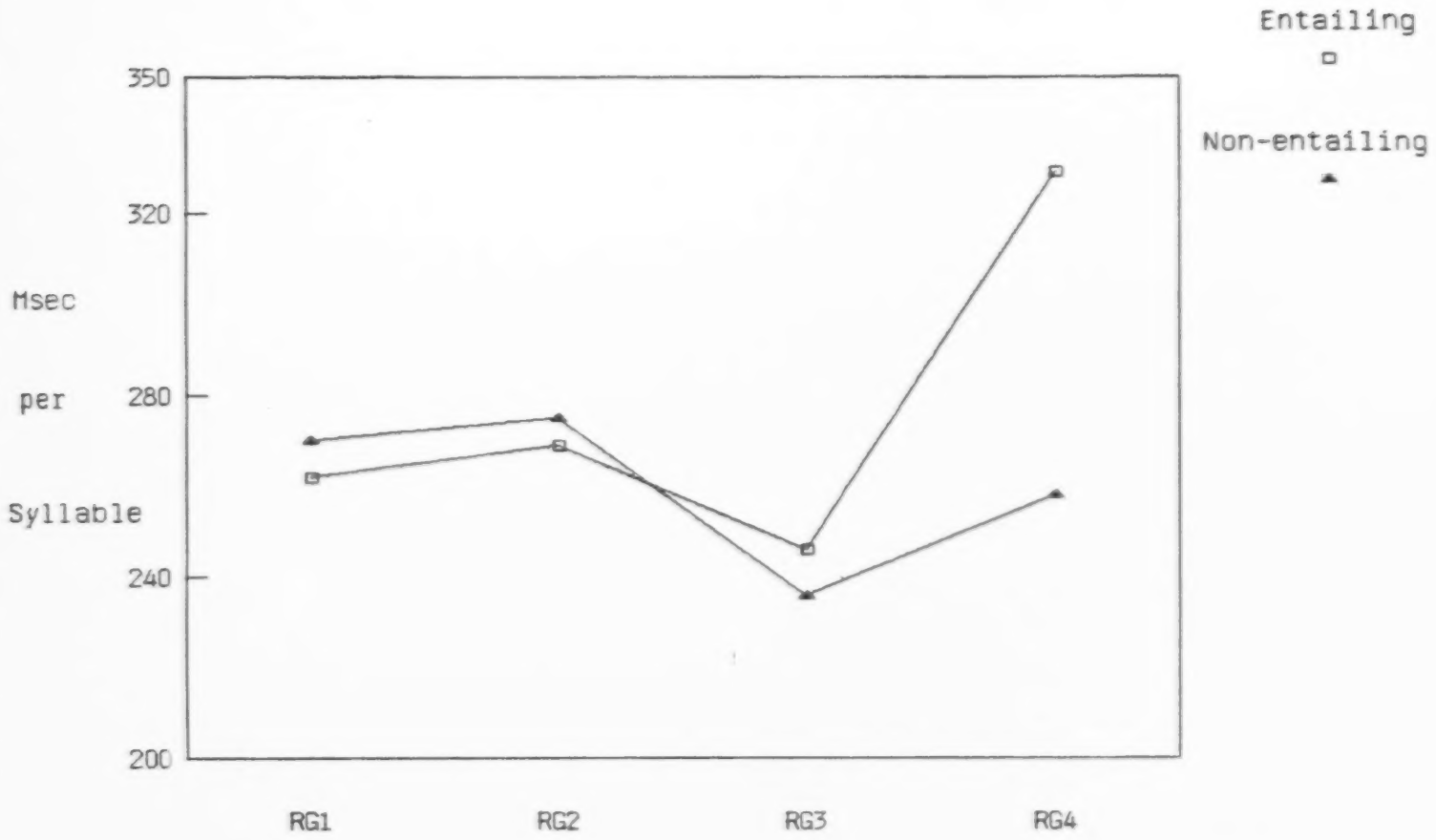

Figure 2. Reading time for base part of Sentence 1.
(Entailment X Reader Group Interaction)

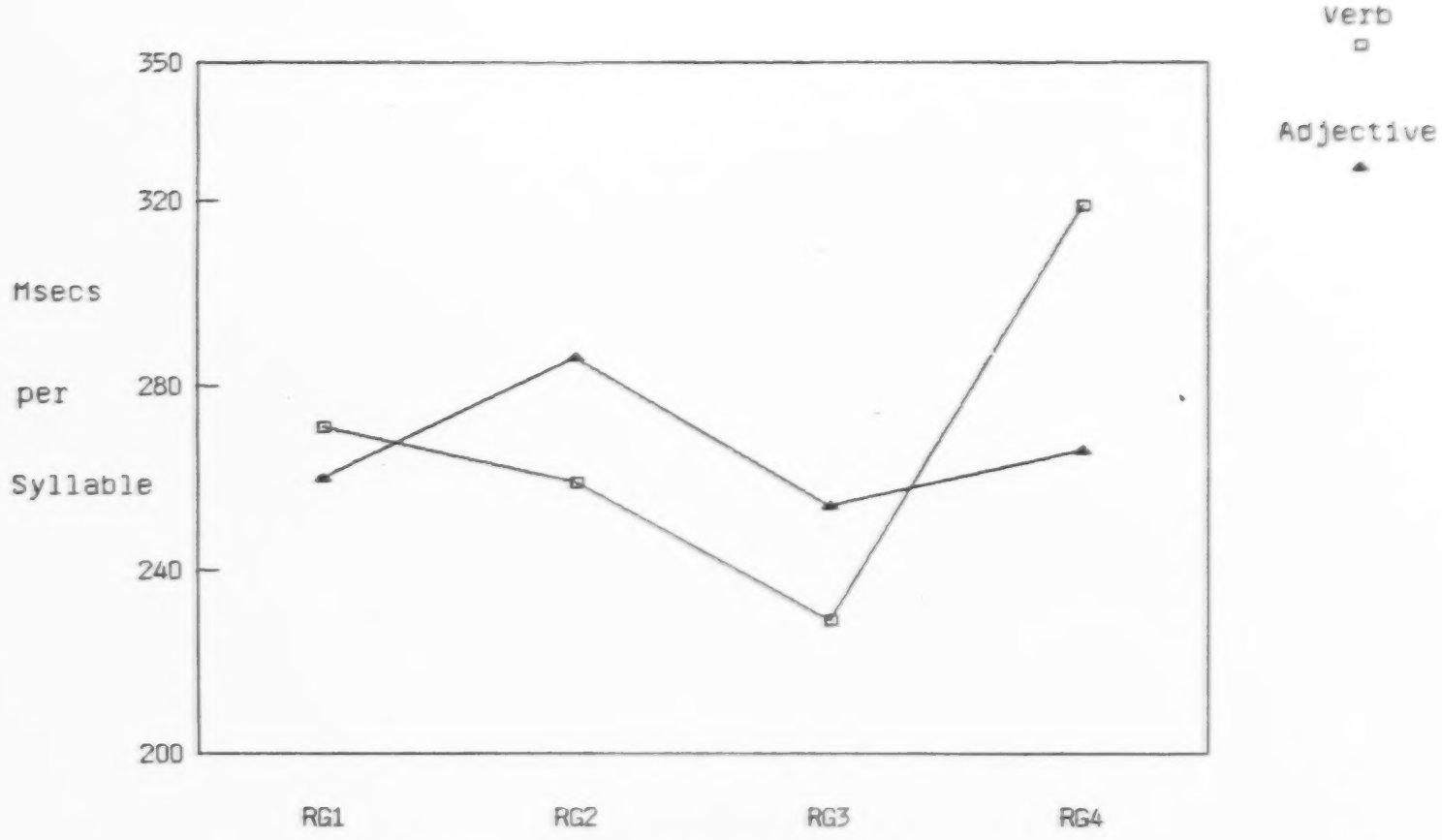

Figure 3. Reading time for base part of Sentence 1.

(Syntactic Class X Reader Group Interaction)

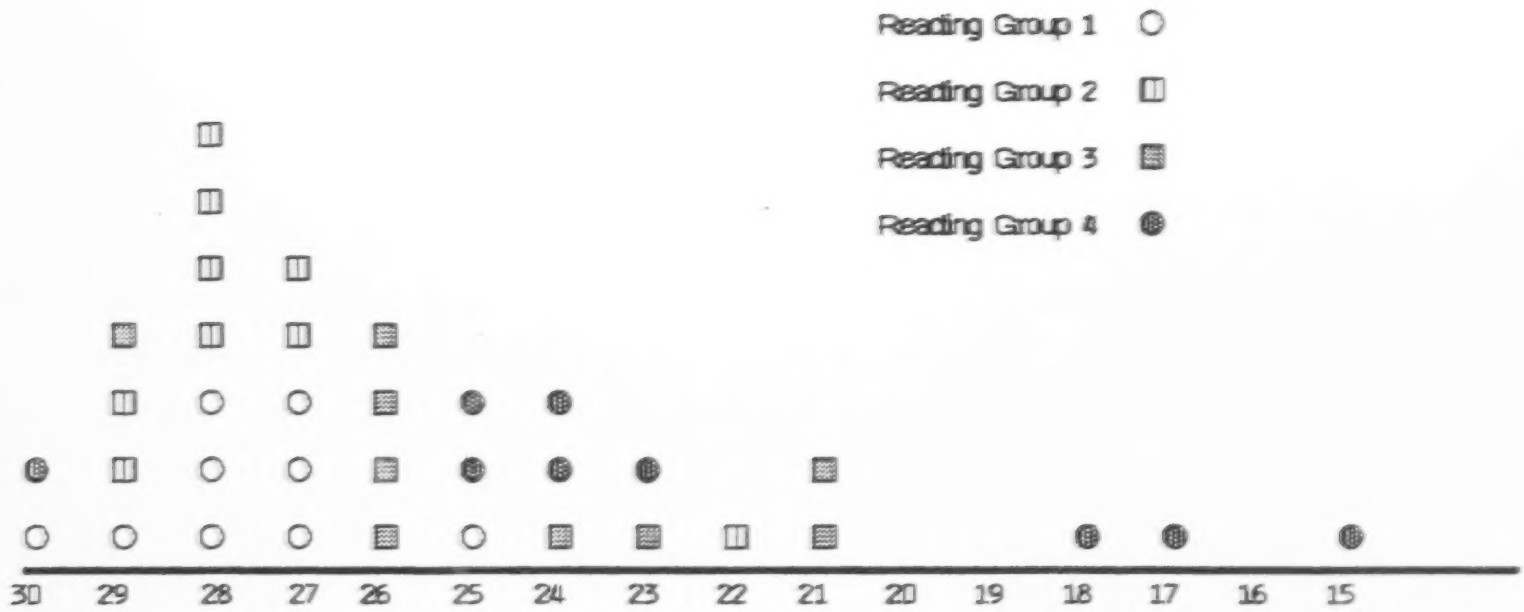
Reading Group 1
Reading Group 2
Reading Group 3
Reading Group 4
30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15
Total number correct out of 30.

Figure 4. Plot of vocabulary scores by reader skill group.

8. REFERENCES

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